UDC 666.1.031

SYNTHETIC RAW MATERIALS FOR FLOAT-GLASS PRODUCTION

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Translated from *Steklo i Keramika*, No. 8, pp. 24 – 26, August, 2010.

It is shown that there is promise in replacing the conventional mix with one that includes synthetic raw materials (SRMs) or consists entirely of SRMs. This will permit economizing raw materials and fuel-energy resources, simplify the technology for preparing glass mix, intensify the technological process of making glass, increase the equality and stability of the characteristics of the glass produced, and improve the environment. SRMs will make it possible to organize glass production in regions which do not have their own raw materials resources.

Key words: float-glass, raw material, quality, mix, synthetic raw materials.

Now, when the competiveness of a product is a determining factor in production, aside from high quality and large assortment, lowering the cost and energy-intensiveness of product is becoming decisive.

Glass production is characterized by substantial consumption of raw materials and fuel-energy resources. The main energy-consuming unit for obtaining glass is the glass-making furnace, in which the loaded mix consisting of a mixture of bulk components transforms at high temperatures into molten glass. The low reactivity of the initial raw materials impedes effective management of the glass-making process, so that one of the most important directions of research is to intensify the process by increasing the reactivity of the mix by changing the activity of it components.

It is well known [1] that more than 13% of the production cost of sheet glass is the cost of raw materials.

Russia possesses large reserves of natural raw materials [2, 3], but the problem lies at the qualitative level of this raw material — its suitability for producing high-quality glass.

When conventional raw materials are used there are arise, first and foremost, the problems of the chemical nonuniformity of the raw materials and the laborious operations needed to prepare, enrich, and purify them.

These problems gave rise to a trend toward partial replacement and even gradual displacement of some natural raw material components by synthetic materials, which are characterized by strictly set properties and consistently high quality.

In addition, active patenting by foreign and domestic companies of the technologies of obtaining and using different synthetic raw materials for the glass industry confirms that the development of new domestic synthetic raw materials and the technologies for obtaining them followed by their subsequent adoption in glass-making practice is a very important and promising problem.

Specialists at the "SIS" JSC and the National Science and Production Center "Kaustik" (Volgograd) are developing since 2002 a technology for obtaining synthetic raw materials in the form of individual silicates — magnesium silicates, calcium silicates — as well as in the form of complex multicomponent compounds — calcium-magnesium silicate, the basic silicate SRM [4].

Synthetic raw materials (SRMs) with different chemical composition (carbonate, silicate) are obtained by a chemical method in a unified process cycle with the possibility of simple and effective modification of an SRM at it production plant by simple additions. The present technology makes it possible to obtain a material with high chemical and granulometric uniformity, characterized by low content of an impurity component (Fe_2O_3) and the possibility of regulating the chemical composition.

The material obtained is in a powder form or consists of spherical or hemispherical granules. In addition, the SRM is characterized by the fact that its constituent compounds sodium, calcium, and magnesium carbonates are hydrosilicates and chemically deposited calcium and magnesium carbonates are amorphous or pseudo-amorphous substances, possess a noticeably low melting temperature and high reactivity, which facility fast melting of the mix and, on the whole, accelerates the glass-making process (from 11 to 23%; see Table 1).

Since producers of high-quality glass are acutely faced with the problem of having supplies of high-quality carbo-

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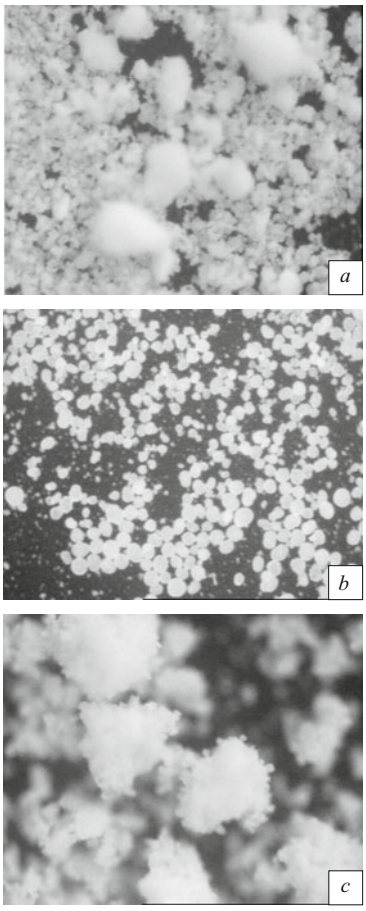

Fig. 1. Texture of carbonate raw material (× 100): *a*) dolomite; *b*) conversion calcium carbonate; *c*) carbonate SRM.

nate raw material, a synthetic carbonate material was chosen for tests on a commercial float-line (in continuous production). It should be note that this product is characterized by the lowest production cost of all SRMs developed.

Since the carbonate raw material is sedimentary rock in which iron-containing impurities are present a finely dispersed state and are uniformly distributed in the volume of the material, this form of the raw material cannot by enriched by environmentally friendly methods [2]. Lumpy dolomite and chalk provided for production require additional energy consumption for special processing, and the main drawback of the finished raw material used (dolomite powder and calcium carbonate) have a fine-grain composition (> 90% 0.125 mm particles).

The synthetic carbonate material (SRM) is a white powder comprising a uniform composition of chemically precipitated calcium and magnesium silicates.

Properties of Carbonate SRM

Exterior form	White powder, spherical particles, soft
Content, wt.%:	
CaO	37.8
MgO	16.5
Fe_2O_3	Traces
moisture	1.5
Ratio CaO : MgO	2.3 : 1
Grain composition, %:	
1.20 – 0.45 mm	
< 0.125 mm	
Bulk mass, kg/m^3	770

Microscopic investigations showed that the texture of carbonate SRM (Fig. 1) consists of fine, strongly coupled, compact agglomerates, while natural carbonates have a finer grain composition and a simple texture — chaotic sticking of individual particles.

Commercial test of the synthetic raw material were performed on a float-line which produces 150 tons/day of molten glass, colored in the bulk, with special light-engineering properties.

The commercial tests included the following: feeding of the raw material in a single unified process cycle, making the mix on batching-mixing equipment of the sectional production subdivision, study of the properties of the mix, assessment of the glass-making properties of the new raw material, and study of the properties of the glass produced.

The glass mix is a mixture of pre-prepared, batched (according to a recipe) mixed and moistened, according to a definite cyclogram, raw materials. The grain composition, bulk density, and moisture content of the raw material have a large effect on the quality and properties of the mix (flowability, compactability, uniformity).

TABLE 1. Glass-Making Properties of Experimental Mixes

Mix		Glass-making time in a periodic furnace, h			Acceleration, %
No.	Form	melting	fining	total	
K	Control (conventional raw material)	17.0	7.0	23.5	–
ÉSh-1	With carbonate SRM	13.5	8.5	21.0	11.0
ÉSh-2	With magnesium silicate	17.0	5.0	22.0	14.0
ÉSh-3	With calcium silicate	16.0	4.0	20.0	15.0
ÉSh-4	With calcium-magnesium silicate	12.0	6.0	18.0	23.0
ÉSh-5	With the basic silicate SRM	16.0	6.0	22.0	14.0

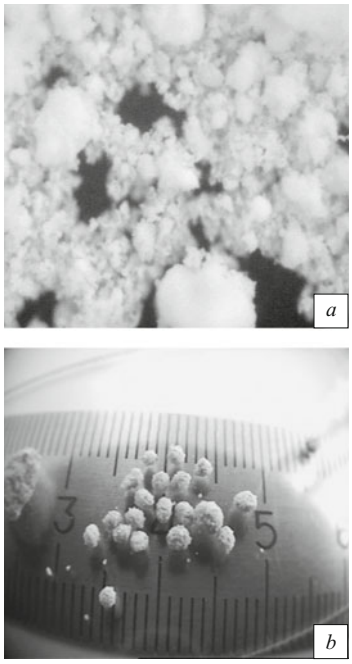

Fig. 2. Texture of mix: *a*) control; *b*) experimental.

It should be noted that the raw materials studied possess good fluidity, flowability, and mixing ability. The experimental mix (EM) based on it is also characterized by good fluidity (the unloading time of 1 tons EM in a furnace was 40 min, while for the control mix the time was 50 min), which is explained by is structure.

Figure 2 shows that texture of the mix: conventional (*a*) and experimental (*b*). The experimental mix consists of separate granules with diameter ranging from 1 to 3 mm, comprising a quartz grain agglomerated into a spherical particle; for a conventional mix the formation of sharply expressed agglomerates is not characteristic. The EM met the quality requirements of the technological rules.

It was also noted that the character of the melting of the mix based on carbonate SRM is different from the control mix. The surface of the loaded EM fissures at high temperatures into individual fragments, which gradually decrease (melt) in height, transforming into a melt without active gas release and foaming.

The results obtained in the course of the observations of the position of the glass-making boundaries confirmed the fact that the experimental mix melts more easily. Thus, on changing to EM in 1 h the mix – glass-making foam boundary shortened by 1.2 m, and after completions of the tests the boundaries returned to their previous limits.

Thus, the results of the commercial tests prove that it is fundamentally possible to use synthetic carbonate raw material for the production of high-quality float-glass. The synthetic carbonated raw material which has been developed is practicable. A mix based on it melts well, and the observed decrease of the mix – glass-making foam boundary by 1.2 m shows that the glass-making process intensifies and the heat loads on the glass-making process can decrease.

It should be noted that the synthetic raw material was used instead of the conventional carbonate raw materials (chalk and dolomite) for one week in 2008 and one month in 2009.

The use of SRMs in glass production will make it possible to solve the problem of economizing raw and fuel-energy processes by means of partial or complete replacement of conventional and natural raw materials. This allows the following: simplifying the technology for preparing glass mix (removing fragmentation, milling, and drying operations), intensifying the technological process of making glass to 23%; increasing the productivity of glass-making furnaces by 11 – 34%; increasing the quality and stability of the characteristics of the glass produced; improving the environmental aspects of glass production by decreasing the amount of gas emitted and the amount of solid wastes, formed during processing of natural raw material. SRMs will make it possible to organized production of glass in regions which do not have their own resource base.

The compositions and methods of obtaining synthetic raw material for the production of glass are protected by five patents, one of which is included in Rospatent in the list "Promising Russian Advances 2009."

The production of experimental batches of synthetic raw materials is continuing.

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